

WHAT IS CLAIMED IS:

- 5 Sub B1
1. A method of promoting the rate of hematopoietic cell multiplication, comprising administering an effective amount of a CXCR4 antagonist to hematopoietic cells.
 2. The method of claim 1, wherein the hematopoietic cells are hematopoietic stem or progenitor cells.
 - 10 3. A method of increasing the circulation of hematopoietic cells in a patient in need of such treatment, comprising administering to the patient an effective amount of a CXCR4 antagonist to mobilize the hematopoietic cells from a marrow locus to a peripheral blood locus.
 - 15 4. The method of claim 1, further comprising introducing a heterologous gene into the hematopoietic cells for gene therapy.
 5. The method of claim 1, wherein the hematopoietic cells are *ex vivo*.
 - 20 6. The method of claim 1, wherein the hematopoietic cells are *in vivo*.
 - 25 Sub B1
 7. The method of claim 1, wherein the hematopoietic cells are selected from the group consisting of hematopoietic stem cells and hematopoietic progenitor cells (including CFU-GEMM, BFU-E, CFU-Meg, CFU-GM, CFU-M/DC CFU-E₀, CFU-Bas, Pro-B cells and lymphoid stem cells), that are known to differentiate into mature myeloid and lymphoid blood cells, including erythrocytes, platelets, neutrophils, monocytes, macrophages, dendritic cells (myeloid and lymphoid related), eosinophils, basophils, mast cells, B cells. and T cells.
 - 30 8. The method of claim 1, wherein the CXCR4 antagonist comprises a CXCR4 antagonist peptide.

9. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSLSYR~~OP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ
VCIDPKLKWIQEYLEKALN (SEQ ID No. 1);

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KGVS~~PS~~YR~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ
VCIDPKLKWIQEYLEKALN (SEQ ID No. 2);

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KGVS~~L~~PYR~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ
VCIDPKLKWIQEYLEKALN (SEQ ID No. 3);

KGVSLS~~P~~R~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ
VCIDPKLKWIQEYLEKALN (SEQ ID No. 4);

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KGVSLSY~~P~~C~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNRQ
VCIDPKLKWIQEYLEKALN (SEQ ID No. 5);

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KGVS~~P~~*SYR~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 6);

KGVS~~L~~P*YR~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 7);

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KGVSLS~~P~~*R~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 8);

KGVSLSY~~P~~*C~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 9);

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KGVS~~B~~tdYR~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 10);

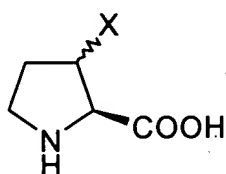
KGVSLS~~B~~tdR~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 11);

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KGVSLS~~B~~tdC~~CP~~CRFFESHVARANVKHLKILNTPNCALQIVARLKNNNR
QVCIDPKLKWIQEYLEKALN (SEQ ID No. 12);

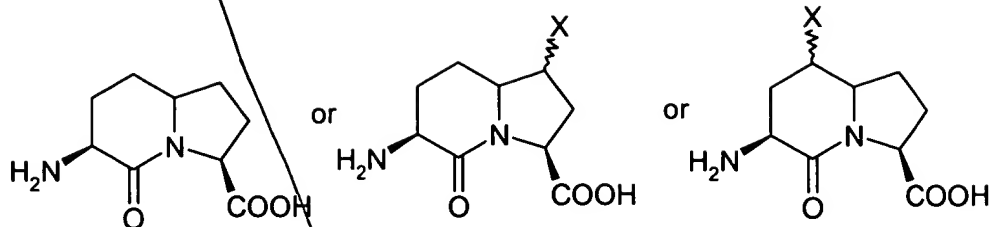
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wherein P* =



with X= Ar, Ar-OH, alkyl and more

and Btd =



X= Alkyl, Ar, Ar-OH and more

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sub a¹²

10. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

- a) KGVSLSYRCPCRFFESH
- b) KGVSLSYRC

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11. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

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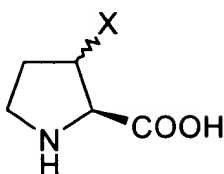
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- KGVS**P**SYRCPCRFFESH (SEQ ID No. 17)
- KGVS**L**PYRCPCRFFESH (SEQ ID No. 18)
- KGVS**L**SPRCPCRFFESH (SEQ ID No. 19)
- KGVS**L**SYPCPCRFFESH (SEQ ID No. 20)
- KGVS**P***SYRCPCRFFESH (SEQ ID No. 21)
- KGVS**L**P*YRCPCRFFESH (SEQ ID No. 22)
- KGVS**L**SP*RCPCRFFESH (SEQ ID No. 23)
- KGVS**L**SY**P***CPCRFFESH (SEQ ID No. 24)
- KGVS**Btd**YRCPCRFFESH (SEQ ID No. 25)
- KGVS**L****Btd**RCPCRFFESH (SEQ ID No. 26)
- KGVS**L**SBtdCPCRFFESH (SEQ ID No. 27)
- KGVS**P**SYRC (SEQ ID No. 28)
- KGVS**L**PYRC (SEQ ID No. 29)
- KGVS**L**SPRC (SEQ ID No. 30)
- KGVS**L**SYPC (SEQ ID No. 31)
- KGVS**P***SYRC (SEQ ID No. 32)
- KGVS**L**P*YRC (SEQ ID No. 33)

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KGVSLSP*RC (SEQ ID No. 34)
 KGVLSYP*C (SEQ ID No. 35)
 KGVSBtdYRC (SEQ ID No. 36)
 KGVSLBtdRC (SEQ ID No. 37)
 KGVSLSBtdC (SEQ ID No. 38)

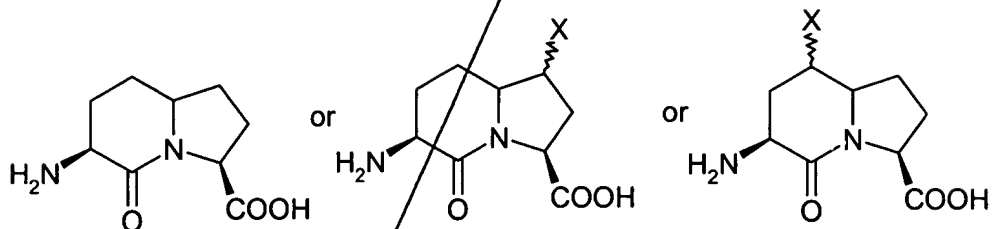
wherein P* =



with X = Ar, Ar-OH, alkyl and more

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and Btd =



X = Alkyl, Ar, Ar-OH and more

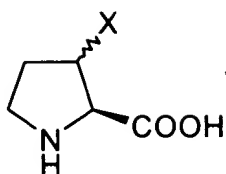
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12. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

| | | | |
|---------------------|---------------------|---------------------|---------------------|
| KGVS P SYRC | KGVSL P YRC | KGVSL S PRC | KGVSLSY P C |
| KGVS P SYRC | KGVSL P YRC | KGVSL S PRC | KGVSLSY P C |
| KGVS P *SYRC | KGVSL P *YRC | KGVSL S *RC | KGVSLSY P *C |
| KGVS P *SYRC | KGVSL P *YRC | KGVSL S *RC | KGVSLSY P *C |
| KGVS Btd YRC | KGVSL Btd RC | KGVSL S BtdC | |
| KGVS Btd YRC | KGVSL Btd RC | KGVSL S BtdC | |

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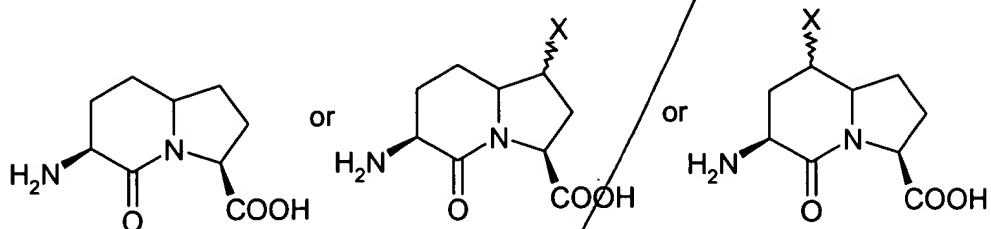
wherein P* =



with X= Ar, Ar-OH, alkyl and more

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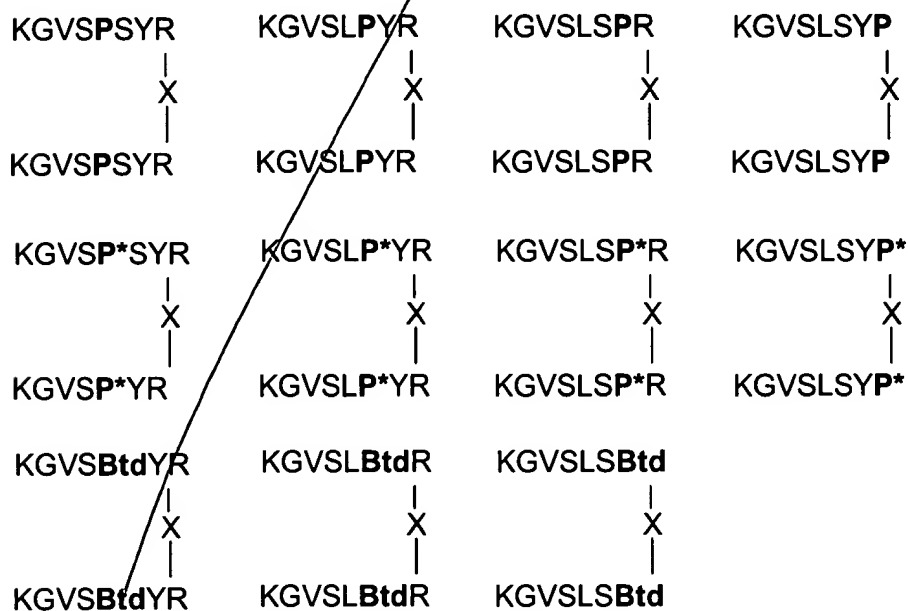
and Btd =



X= Alkyl, Ar, Ar-OH and more

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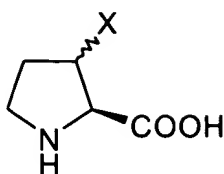
13. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:



wherein X is a natural or unnatural amino acid linker between each of the arginines at position 8 in each sequence; and,

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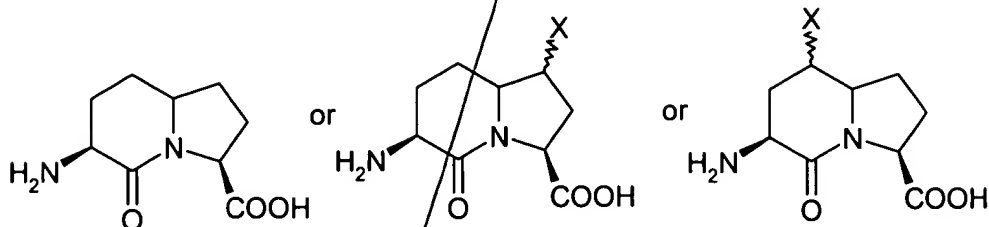
wherein P* =



with X= Ar, Ar-OH, alkyl and more

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and Btd =



X= Alkyl, Ar, Ar-OH and more

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14. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVLSYRCP CRFF-G_n-LKWIQEYLEKALN (SEQ No. 63)

KGVLSYRCP CRFFESH-G_n-LKWIQEYLEKALN (SEQ No. 64)

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wherein n is an integer from 0 to 10.

15. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVLSYRCP CRFF-(CH₂)_n-LKWIQEYLEKALN (SEQ No. 65)

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KGVLSYRCP CRFFESH-(CH₂)_n-LKWIQEYLEKALN (SEQ No. 66)

where n is an integer from 1 to 20.

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16. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSPSYRCP CRFF-GGGG-LKWIQEYLEKALN;

KGVSLPYRCP CRFF-GGGG-LKWIQEYLEKALN;

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KGVSLSPRCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVLSYPCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSPSYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSLPYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSLSPRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVLSYPCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSPSYRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLPYRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLSPRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVLSYPCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSPSYRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLPYRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLSPRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVLSYPCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN,

wherein n is an integer from 1 to 20.

17. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSP*SYRCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSLP*YRCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSLSP*RCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVLSYP*CPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSP*SYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSLP*YRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSLSP*RCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVLSYP*CPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSP*SYRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLP*YRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLSP*RCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVLSYP*CPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSP*SYRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLP*YRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;

KGVSLSP*RCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLSYP*CPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;

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KGVSBtdYRCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSLBtdRCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSLSBtdCPCRFF-GGGG-LKWIQEYLEKALN;
 KGVSBtdYRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSLBtdRCPCRFFESH-GGGG-LKWIQEYLEKALN;
 KGVSLSBtdCPCRFFESH-GGGG-LKWIQEYLEKALN;

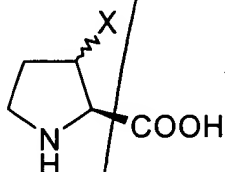
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KGVSBtdYRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLBtdRCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLSBtdCPCRFF-(CH₂)_n-LKWIQEYLEKALN;
 KGVSBtdYRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLBtdRCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN;
 KGVSLSBtdCPCRFFESH-(CH₂)_n-LKWIQEYLEKALN,

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wherein n is an integer from 0 to 20 and

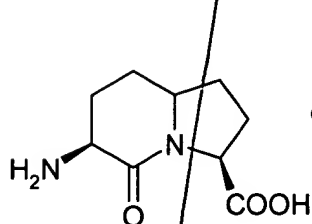
wherein P* =



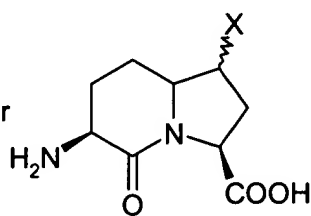
with X= Ar, Ar-OH, alkyl and more

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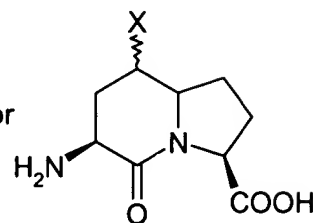
and Btd =



or



or



X= Alkyl, Ar, Ar-OH and more

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18. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN



KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN



KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN



KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN



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19. A CXCR4 antagonist peptide selected from the group consisting of:

KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN



KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN



KGVSLSYRCPCRFFGGGGLKWIQEYLEKALN



KGVSLSYRCPCRFFESHGGGGLKWIQEYLEKALN



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20. The method of claim 8, wherein the CXCR4 antagonist peptide is selected from the group consisting of:

KGVSLSYRCPCRFFGGGGSKPGVIFLTKRSRQV;

KGVSLSYRCPCRFF(CH₂)_n SKPGVIFLTKRSRQV;

KGVSLSYRCPCRFFGGGGEEWVQKYVDDLELSA;

where n is 0 or an integer between 1 and 20.

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| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 | 2051 | 2052 | 2053 | 2054 | 2055 | 2056 | 2057 | 2058 | 2059 | 2060 | 2061 | 2062 | 2063 | 2064 | 2065 | 2066 | 2067 | 2068 | 2069 | 2070 | 2071 | 2072 | 2073 | 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 | 2081 | 2082 | 2083 | 2084 | 2085 | 2086 | 2087 | 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 | 2095 | 2096 | 2097 | 2098 | 2099 | 2100 | 2101 | 2102 | 2103 | 2104 | 2105 | 2106 | 2107 | 2108 | 2109 | 2110 | 2111 | 2112 | 2113 | 2114 | 2115 | 2116 | 2117 | 2118 | 2119 | 2120 | 2121 | 2122 | 2123 | 2124 | 2125 | 2126 | 2127 | 2128 | 2129 | 2130 | 2131 | 2132 | 2133 | 2134 | 2135 | 2136 | 2137 | 2138 | 2139 | 2140 | 2141 | 2142 | 2143 | 2144 | 2145 | 2146 | 2147 | 2148 | 2149 | 2150 | 2151 | 2152 | 2153 | 2154 | 2155 | 2156 | 2157 | 2158 | 2159 | 2160 | 2161 | 2162 | 2163 | 2164 | 2165 | 2166 | 2167 | 2168 | 2169 | 2170 | 2171 | 2172 | 2173 | 2174 | 2175 | 2176 | 2177 | 2178 | 2179 | 2180 | 2181 | 2182 | 2183 | 2184 | 2185 | 2186 | 2187 | 2188 | 2189 | 2190 | 2191 | 2192 | 2193 | 2194 | 2195 | 2196 | 2197 | 2198 | 2199 | 2200 | 2201 | 2202 | 2203 | 2204 | 2205 | 2206 | 2207 | 2208 | 2209 | 2210 | 2211 | 2212 | 2213 | 2214 | 2215 | 2216 | 2217 | 2218 | 2219 | 2220 | 2221 | 2222 | 2223 | 2224 | 2225 | 2226 | 2227 | 2228 | 2229 | 2230 | 2231 | 2232 | 2233 | 2234 | 2235 | 2236 | 2237 | 2238 | 2239 | 2240 | 2241 | 2242 | 2243 | 2244 | 2245 | 2246 | 2247 | 2248 | 2249 | 2250 | 2251 | 2252 | 2253 | 2254 | 2255 | 2256 | 2257 | 2258 | 2259 | 2260 | 2261 | 2262 | 2263 | 2264 | 2265 | 2266 | 2267 | 2268 | 2269 | 2270 | 2271 | 2272 | 2273 | 2274 | 2275 | 2276 | 2277 | 2278 | 2279 | 2280 | 2281 | 2282 | 2283 | 2284 | 2285 | 2286 | 2287 | 2288 | 2289 | 2290 | 2291 | 2292 | 2293 | 2294 | 2295 | 2296 | 2297 | 2298 | 2299 | 2300 | 2301 | 2302 | 2303 | 2304 | 2305 | 2306 | 2307 | 2308 | 2309 | 2310 | 2311 | 2312 | 2313 | 2314 | 2315 | 2316 | 2317 | 2318 | 2319 | 2320 | 2321 | 2322 | 2323 | 2324 | 2325 | 2326 | 2327 | 2328 | 2329 | 2330 | 2331 | 2332 | 2333 | 2334 | 2335 | 2336 | 2337 | 2338 | 2339 | 2340 | 2341 | 2342 | 2343 | 2344 | 2345 | 2346 | 2347 | 2348 | 2349 | 2350 | 2351 | 2352 | 2353 | 2354 | 2355 | 2356 | 2357 | 2358 | 2359 | 2360 | 2361 | 2362 | 2363 | 2364 | 2365 | 2366 | 2367 | 2368 | 2369 | 2370 | 2371 | 2372 | 2373 | 2374 | 2375 | 2376 | 2377 | 2378 | 2379 | 2380 | 2381 | 2382 | 2383 | 2384 | 2385 | 2386 | 2387 | 2388 | 2389 | 2390 | 2391 | 2392 | 2393 | 2394 | 2395 | 2396 | 2397 | 2398 | 2399 | 2400 | 2401 | 2402 | 2403 | 2404 | 2405 | 2406 | 2407 | 2408 | 2409 | 2410 | 2411 | 2412 | 2413 | 2414 | 2415 | 2416 | 2417 | 2418 | 2419 | 2420 | 2421 | 2422 | 2 |
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|--|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---|